

# ATR Bioanalytical Sensor with 3D Spatial Resolution

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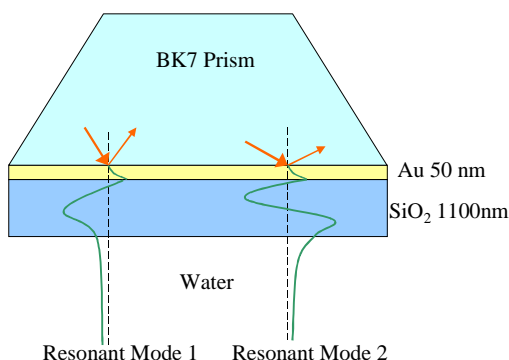
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This paper reports the attenuated total reflection (ATR) sensor with the capability identifying the 3D spatial distribution of bio-interactions. The proposed ATR sensor determines not only the horizontal 2D-image as the conventional SPR sensor does but also the vertical positions of real-time bio-interactions. This ATR sensor may be extended with n-fold resonant angles that provide n-times independent information to obtain the n-layer vertical distribution. In the paper, a sensor of n=2 is demonstrated theoretically and will be verified experimentally.

Recent progress of the multilayer ATR sensors named coupled plasmon-waveguide resonance [1] has been demonstrated the increase of the sensing sensitivity and the resolution of the anisotropy of bio-interactions using both TM and TE polarized light with single resonant angle. Figure 1 illustrates the schematic drawing of this ATR sensor with an increasing waveguide thickness to perform two modes of the standing wave in the waveguide resonator (Fig. 1). Additional modes are obtained using a thicker waveguide with a higher index. Two resonance angles either for TE or TM waves are observed in Fig. 2 that plots the reflectivity calculated by the Fresnel Formula. Each resonance performs different probing depth as shown in Fig. 3. The angle shifts  $\Delta\theta_i$  of ith resonance as a function of the  $z_j$  is shown in Fig. 3, where  $z_j$  is the distance from j perturbation layer to the waveguide. The layers used in the calculation are 5-nm thick with 1% index deviation.

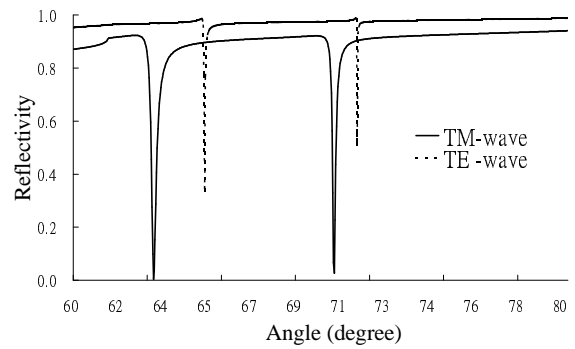
## REFERENCES

1. Z. Salamon, M. F. Brown, and G. Tollin, pp. 213-219, Trends in Biomedical Sciences Vol. 24, Issue: 6, June (1999).

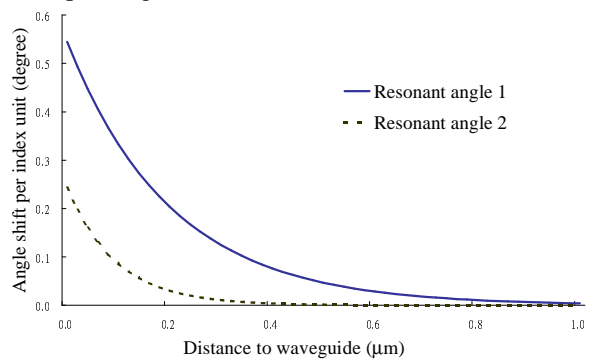


**Figure 1:** Resonant modes of ATR sensor. In the case

of an 1100nm SiO<sub>2</sub> waveguide, two resonant modes occur with different configuration of the standing wave in the waveguide. Each mode has the independent resonant angle and its corresponding evanescent wave.



**Figure 2:** Reflectivity curves of ATR sensor configured in 50nm gold layer covered by the waveguide of 1100nm SiO<sub>2</sub> with water in the probing side. There are two modes for TM- and TE-wave, respectively. The TE resonance has a sharper bandwidth and therefore higher sensitivity than the corresponding terms of the TM resonance.



**Figure 3:** Calculated angle shifts of two resonant modes as a function of distance  $z$  that is the distance from the perturbation layer to the waveguide.